

April 4, 1939.

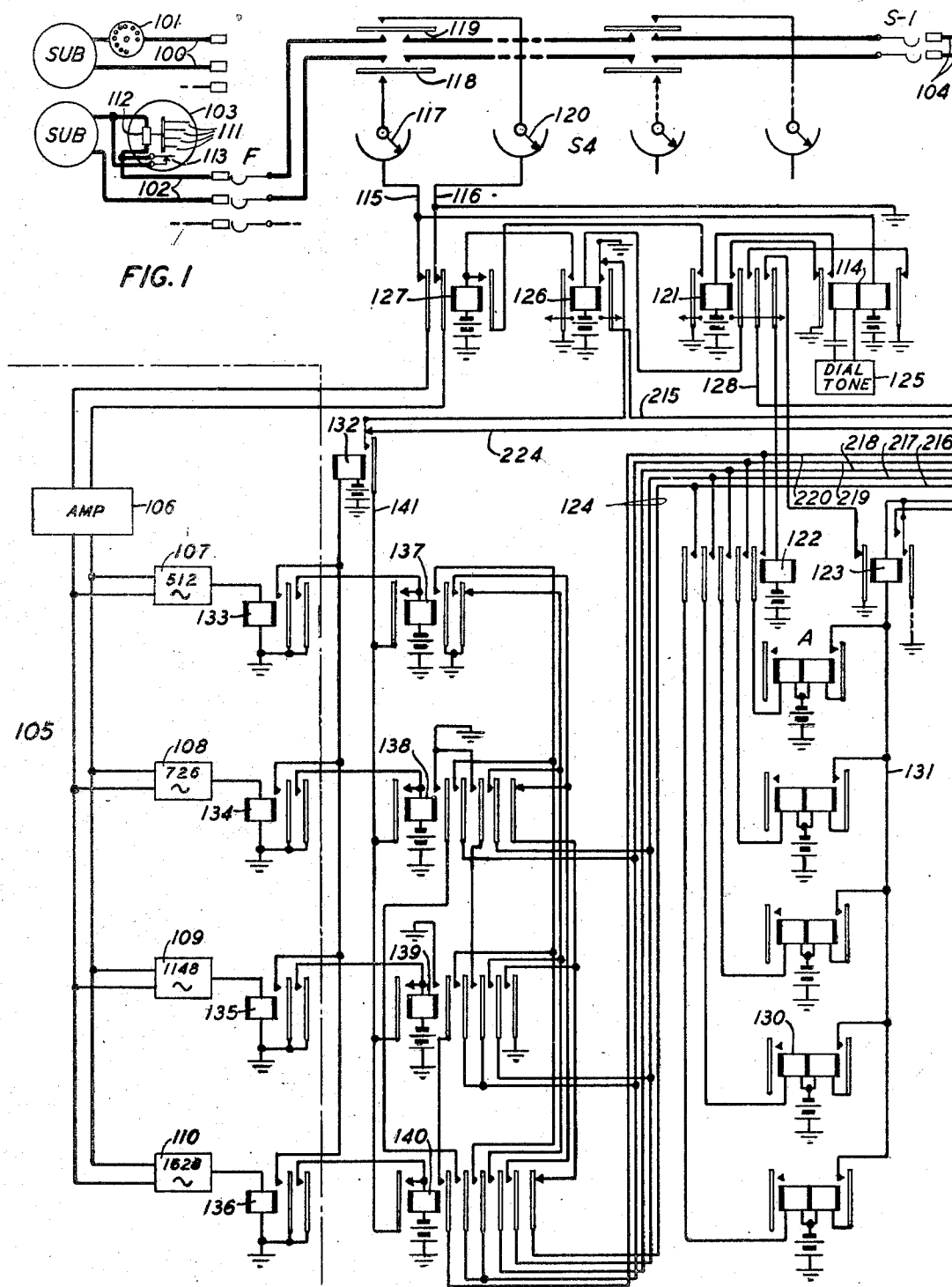
H. M. BASCOM

2,153,129

TELEPHONE SYSTEM

Filed Aug. 31, 1937

3 Sheets-Sheet 1



INVENTOR
H. M. BASCOM
BY *M. J. McFenney*
ATTORNEY

April 4, 1939.

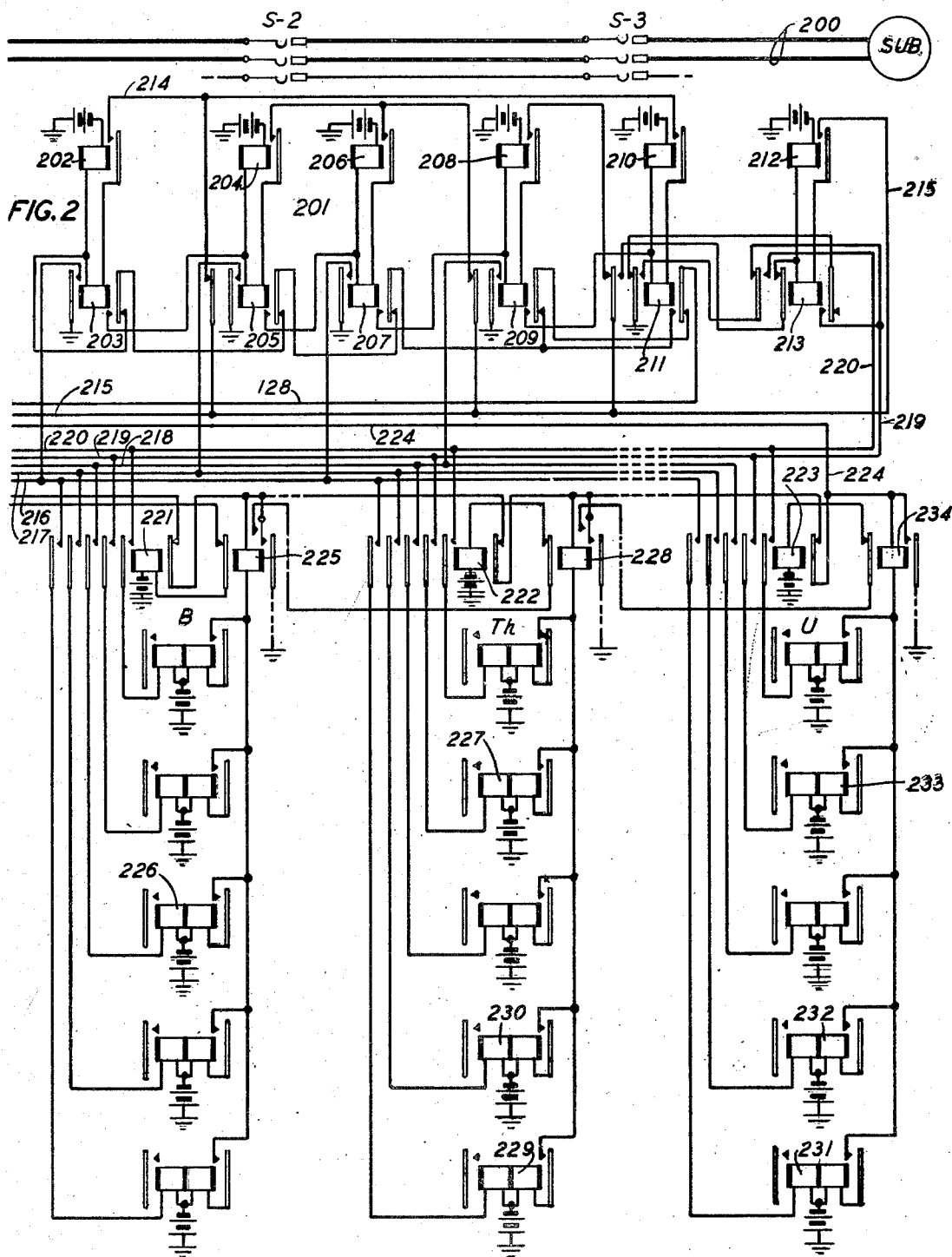
H. M. BASCOM

2,153,129

TELEPHONE SYSTEM

Filed Aug. 31, 1937

3 Sheets-Sheet 2



INVENTOR

H. M. BASCOM

BY

M. T. McKenney

ATTORNEY

April 4, 1939.

H. M. BASCOM

2,153,129

TELEPHONE SYSTEM

Filed Aug. 31, 1937

3 Sheets-Sheet 3

FIG. 4

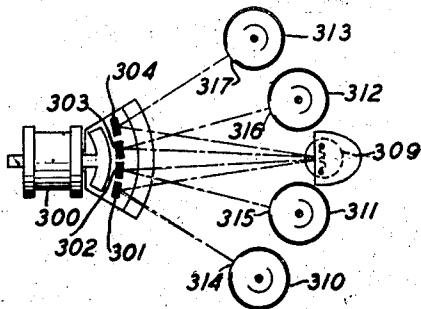


FIG. 5

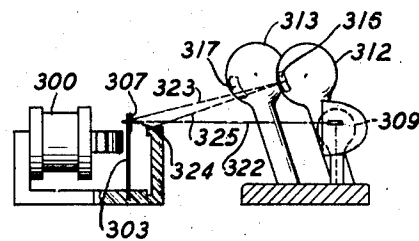
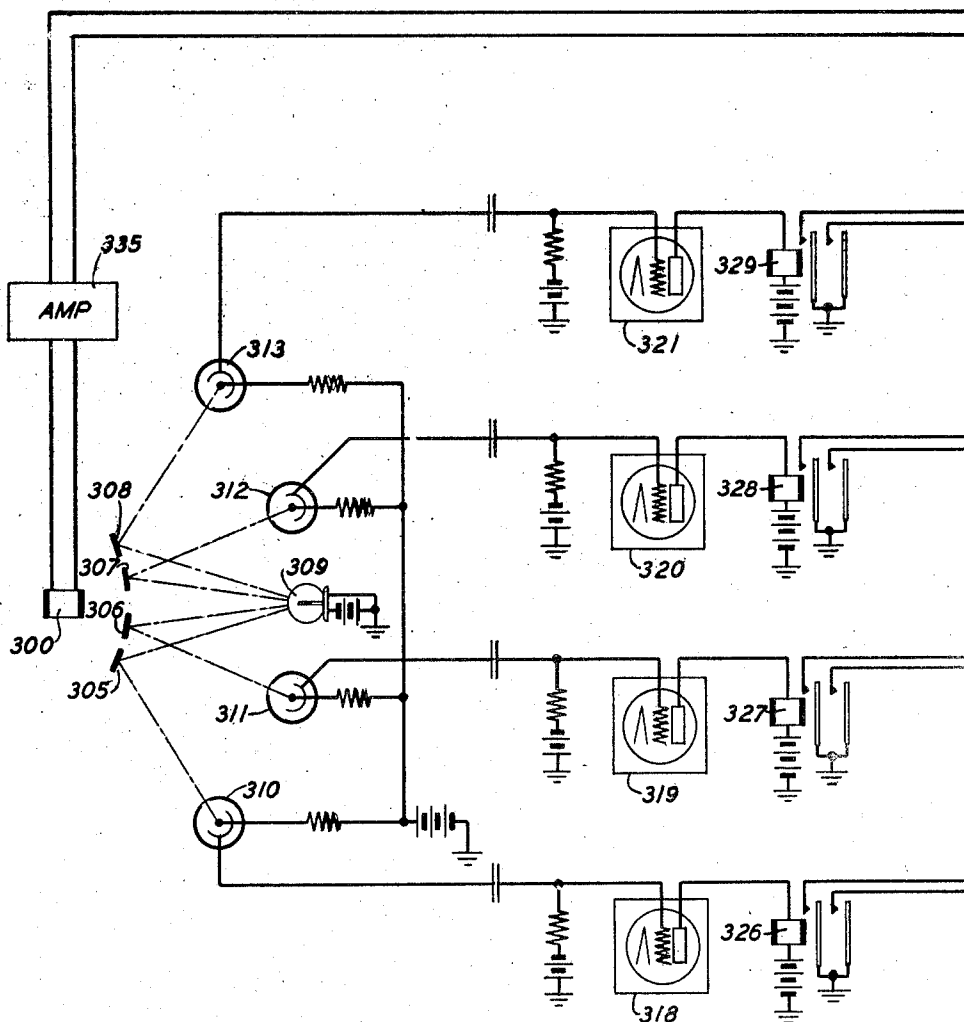


FIG. 3



INVENTOR
H. M. BASCOM
BY
M. S. McFarney
ATTORNEY

UNITED STATES PATENT OFFICE

2,153,129

TELEPHONE SYSTEM

Henry M. Bascom, Brooklyn, N. Y., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application August 31, 1937, Serial No. 161,749

7 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to systems in which automatic switches are used for establishing connections.

The objects of the invention are to simplify the acts necessary on the part of subscribers and operators in transmitting and in recording telephone designations; to improve the efficiency and to increase the speed of operation of the equipment, and otherwise to improve systems of this kind.

Systems have been proposed heretofore in which the designations of called lines or trunk circuits are transmitted from one point to another by means of currents of different frequencies, the frequencies singly or in combination serving to characterize the different numerals or other characters of the designation. And it is, of course, the general practice to transmit telephone designations by direct current impulses, the number of impulses in the several series being representative of the corresponding numerals or other characters of the designation.

According to the present invention advantages are secured in these prior systems by arranging the same central office mechanism to respond to designation impulses sent over a line by means of the usual direct current impulse transmitter at the subscriber's station and also to respond to designation currents of different frequencies transmitted over a subscriber's line or trunk by means of a transmitter designed to send alternating currents of different frequencies representative of the wanted designation. By this provision some of the lines may be equipped with ordinary impulse dials and other lines with tone transmitting devices, and the central office register mechanism is capable of functioning with both kinds of lines.

Another feature of the invention is a system in which the central office is equipped with a frequency selective mechanism comprising electromagnetic devices and tuned vibrating reeds carrying mirrors for directing beams of light to the sensitive elements of photoelectric cells. These tuned reeds are set in vibration in accordance with the frequencies of the currents received, which represent the different parts of the wanted designation, and the photoelectric cells are correspondingly excited to cause the operation of the relays of the usual designation registers. These registers in turn serve to control the selective operation of the switches to establish the desired connection.

The foregoing and other features of the invention will be described more fully in detail in

the following specification and will also be set forth in the appended claims.

In the drawings accompanying this specification:

Figs. 1 and 2 taken together illustrate an automatic telephone system in which some lines are equipped with impulse dials and others with tone transmitting dials and in which a central office is equipped with register senders arranged to cooperate with lines of either kind to control the selective operation of the switches in the central office to complete telephone connections;

Fig. 3 shows a modified form of the tone receiving equipment in the central office register mechanism in which photoelectric devices are employed for selectively recording the numbers transmitted; and

Figs. 4 and 5 are detailed illustrations of the photoelectric receiving mechanism.

The system shown in the drawings is abbreviated to a large extent, all parts not essential to an understanding of the invention being omitted for the sake of clearness and brevity. The invention relates particularly to the transmission of wanted designations over a telephone line or circuit for the purpose of controlling the selective operations necessary to complete the corresponding connections to subscribers' lines, to operators' positions or to other stations; and it is therefore applicable to a wide variety of types of communication systems and particularly to those of the kind in which register mechanisms are employed at the central office for registering the designations transmitted and for controlling the selective operation of automatic switches to complete the connections. Accordingly, the system chosen to illustrate the invention is one in which the central office is equipped with automatic switches of the panel type and with common register senders for registering the designations transmitted to the central office from subscribers' stations. And it will be obvious that other forms of switches may be used for establishing the connections, such as the well-known step-by-step switches, or switches of the cross-bar type.

Referring to the drawings, two subscribers' lines are shown appearing in the contact bank of the line-finder switch F. The subscriber's line 100 is equipped with an ordinary impulse dial 101, which sends series of direct current impulses representative of the letters and numbers in a called designation, and these impulses are received and registered at the central office. The other subscriber's line, line 102, is equipped at

the substation with a designation transmitter 103, which is designed to produce in the line alternating currents of different frequencies, the frequency or combination of frequencies being
 5 chosen to represent the different letters and numbers constituting the wanted designations. These alternating currents are received at the central office and, as will be explained presently, utilized to register the corresponding parts of
 10 the designations on the same registering equipment as is used to register the numbers of the designations received on other calls from lines equipped with impulse dials.

The line finder F is joined to a first or district
 15 selector switch S-1, and these two switches together constitute a link for extending subscribers' lines to trunks 104 leading to incoming selectors, such as the selector S-2, which may be located in the same office with the finder-district link or in
 20 a distant machine switching office. The incoming selector S-2 in turn has access to a final selector S-3 which serves to complete the connections to called subscribers' lines. One of these lines, line 200, is shown appearing in the terminals
 25 of the final selector S-3.

The line finder and district link has access through a sender-selector switch S-4 to any one of a number of common register-sender mechanisms. The remainder of Figs. 1 and 2 of the
 30 drawings discloses in detail some of the essential parts of one of these register senders. The number of registers employed in these senders will, of course, vary with the requirements of the exchange area. In some of the larger areas office
 35 codes require two or three code registers, and the numerical part of the designation usually requires four registers. In the present system two office code registers A and B are shown. Also the thousands numerical register Th and the
 40 units numerical register U are shown, it being understood that the hundreds and tens registers would be provided and inserted between these two as illustrated by the broken lines. These registers, each of which comprises five register
 45 relays, are operated to register the corresponding parts of a designation either by means of a counting relay set 201 or by means of the frequency selective equipment 105. The counting relay set
 50 201 is effective to receive dial pulses when the sender is serving a subscriber's line equipped with a dial 101, and the frequency selecting mechanism 105 is effective to receive the designation currents when the sender is serving a subscriber's line provided with a tone-designation transmitter 103.

The frequency selecting mechanism 105 includes an amplifier 106 for amplifying the alternating currents incoming from the subscriber's line and a plurality of selective circuits 107, 108, 109 and 110. These selective circuits may include
 60 any suitable resonant devices such as filters which are tuned to select currents of particular frequencies and to exclude currents of other frequencies. They may also include any suitable devices for amplifying and rectifying the chosen
 65 currents to effect the operation of relays connected to their output circuits.

Inasmuch as the present invention is concerned particularly with those functions of the central-office sender which have to do with the receiving
 70 and registering of the designation information, much of the equipment for performing the numerous other functions of the sender has been omitted. For an understanding of the details of the omitted parts reference may be had to the
 75 many prior-art patents showing them in full. In

particular reference is made to the patent to Raymond et al. 1,862,549 of June 14, 1932, and to the patent to Stearn and Scudder 1,395,977 of November 1, 1921. The finder and selector switches,
 5 which are illustrated diagrammatically in the drawings, may be of any suitable and well-known type, such as the switches disclosed in the Raymond et al. and Stearn et al. patents above noted.

The designation transmitter 103 at the subscriber's station may be of any suitable construction. As illustrated herein, it comprises a plurality of vibratory reeds 111, which are tuned to
 10 vibrate at different natural frequencies, and a microphone transmitter 112 sensitive to the vibration of the reeds 111 to produce in the line 102
 15 currents having frequencies corresponding to the particular reed or combination of reeds set in vibration. The transmitter also is provided with a set of contacts 113 normally short-circuiting
 20 the transmitter 112. When the transmitter is manipulated to set the reeds in vibration, the contacts 113 are opened in any suitable way to render the microphone transmitter 112 effective. Any suitable mechanical means may be used for
 25 plucking the reeds 111 to cause their vibration. Reference is made, for example, to the structure and operation of the transmitter disclosed and described in my copending application Serial No. 161,750, filed Aug. 31, 1937.

The operation of the system will now be described in detail, and for this purpose it will be
 30 assumed, first, that the subscriber of line 100, which is equipped with an ordinary impulse dial, wishes to converse with the subscriber of line 200. When the subscriber of line 100 initiates the call,
 35 the line finder F is started in operation in the well-known manner and advances its brushes into engagement with the terminals of the line 100. Also the operation of the sender-selector switch S-4 is initiated automatically, and this switch
 40 seizes the terminals individual to an idle register sender for the purpose of associating the sender with the subscriber's line to receive the register the wanted designation. When these automatic
 45 operations have been completed, an impulse transmitting circuit is established and may be traced from battery through the right winding of impulse relay 114, conductor 115, brush 117 of
 50 the sender selector, closed contacts of sequence switch spring 118, thence through the middle brush of the line finder F, over the subscriber's line 100, and returning through the uppermost
 55 brush of line finder F, closed contacts of sequence switch spring 119, sender-selector brush 120, conductor 116, to ground. The impulse relay 114
 60 operates in this circuit and closes an obvious circuit for the slow-release relay 121. Relay 121 closes the circuit from battery through the winding of relay 122, outermost contact of relay 121,
 65 to ground at the back contact of relay 123. Relay 122 operates and associates the counting relay set 201 with the first code register A by extending the group of leads 124 through to the windings of the relays of said register. Tone current from the source 125 flowing in the left winding of relay
 70 114 induces in the right winding of said relay a current which flows over the subscriber's line, giving him a characteristic tone in his receiver. The equipment is now in readiness for dialing, and the tone received by the subscriber apprises
 75 him of this fact.

The calling subscriber manipulates his dial 101 to transmit six series of impulses. The first two of these series represent code letters designating the name of the office in which the called line 200
 75

appears, and the remaining four series represent the numerals in the four digital places of the subscriber's line number. The impulses of each of these series operate the pulse relay 114, and this relay causes the successive operation of the counting relays 201, the number of pairs of counting relays being operated depending upon the number of impulses in the series. In order to describe the operation of the counting relays 201, it will be assumed that a series of ten impulses are transmitted. When the subscriber's line is opened for the first impulse, relay 114 releases and closes a circuit from ground through its left armature and back contact, closed contact of relay 121, through the winding of slow-release relay 126, to battery. Relay 126 operates and closes an obvious circuit for relay 127. Relay 127 operates and locks through its contacts to ground through a closed contact of relay 121. The purpose of operating relay 127 is to sever the impulse receiving leads 115 and 116 from the frequency selective equipment 105, this latter equipment not being used on a call from a line provided with an impulse dial.

The release of relay 114 on the first opening of the subscriber's line also closes a circuit from ground through its right contact, closed contact of relay 121, conductor 128, right back contacts of relays 211, 209, 207, 205 and 203 in series, winding of relay 202 to battery. Relay 202 operates and closes a circuit from battery through its winding and the winding of relay 203, contact of relay 202, conductor 214, back contact of relay 205, conductor 215 to ground at the front contact of relay 126. Relay 203 is shunted by the circuit above traced for relay 202 and does not operate. As soon as the subscriber's line is closed to complete the first impulse, relay 114 reoperates and opens the energizing circuit of relay 202. Relay 203 now operates in series with relay 202 in the circuit traced by way of conductors 214 and 215. Thus at the end of a single impulse representing the digit 1, relays 202 and 203 are operated, and relay 203 at its left contact applies ground potential to the conductor 216.

When relay 114 releases on the opening of the line for the second impulse, the grounded conductor 128 is extended through the front contact of relay 203 and the winding of relay 204 to battery. Relay 204 operates and prepares a series operating circuit for relay 205, but the latter relay being short-circuited does not operate at this time. At the end of the second impulse the short circuit is removed on the operation of relay 114, and relay 205 operates in series with relay 204. The holding circuit for relays 204 and 205 extends through the back contact of relay 209 to grounded conductor 215. Relay 205 in operating opens the circuit of relays 202 and 203, and these relays release. Thus at the end of two impulses relays 204 and 205 are operated, and relay 205 applies ground potential to the conductor 217.

When relay 114 releases for the third impulse, the grounded conductor 128 is extended through the front contact of relay 205 and the winding of relay 206 to battery. Relay 206 operates, and, when relay 114 reoperates, relay 207 operates in series with relay 206 in a circuit traceable through the back contact of relay 209 to the grounded conductor 215. Thus at the end of the third impulse both relays 205 and 207 are operated, and ground potential is applied to conductors 216 and 217.

On the release of relay 114 for the fourth impulse the grounded conductor 128 is extended

through the front contact of relay 207 and the winding of relay 208 to battery. Relay 208 operates, and, when relay 114 reoperates at the end of the impulse, relay 209 operates in series with relay 208 in a circuit through the back contact of relay 211 to the grounded conductor 215. Relay 209 in operating causes the release of relays 204, 205, 206 and 207. Thus at the end of four impulses relays 208 and 209 are operated, and ground is applied from a front contact of relay 209 to conductor 218.

When relay 114 releases at the beginning of the fifth impulse, conductor 128 is extended through the front contact of relay 209 and the winding of relay 210 to battery. Relay 210 operates, and, when relay 114 reoperates, relay 211 is energized in series with relay 210 in a circuit traceable over conductor 214 through the back contact of relay 205 to the grounded conductor 215. Relay 211 in operating opens the holding circuit of relays 208 and 209. Thus at the end of five impulses relays 210 and 211 are operated, and relay 211 closes a circuit from ground through its inner left front contact, outer left back contact of relay 213, to conductor 219. Relay 211 also closes the circuit from the grounded conductor 215, outer left front contact of relay 211, inner back contact of relay 213, winding of relay 212, to battery. Relay 212 operates and closes the circuit from battery through its winding and the winding of relay 213, contact of relay 212 to the grounded conductor 215. Relay 213, however, is short-circuited as long as relay 211 remains energized.

When relay 114 releases at the beginning of the sixth impulse, a conductor 128 is extended through the front contact of relay 211, thence through the back contacts of relays 207, 205 and 203 in series, winding of relay 202, to battery. Relay 202 operates, and, when relay 114 reoperates, relay 203 operates in series with relay 202 in the circuit previously traced to the grounded conductor 215. Thus at the end of the sixth impulse relays 202, 203, 210, 211 and 212 are operated and ground potential is placed on conductors 216 and 219.

At the beginning of the seventh impulse relay 114 operates, and conductor 128 is extended through the front contact of relay 203 and the winding of relay 204 to battery. Relay 204 operates. When relay 114 reoperates, relay 205 energizes. Relay 205 opens the holding circuits of relays 202, 203, 210 and 211 and these relays release. Relay 211 removes the short circuit from relay 213, and the latter relay operates in series with relay 212 to the grounded conductor 215. Thus at the end of the seventh impulse relays 204, 205, 212 and 213 are operated. Relay 205 grounds the conductor 217 and relays 211 and 213 complete a circuit from ground through the back contact of relay 211, right front contact of relay 213 to conductor 219.

At the beginning of the eighth impulse relay 114 releases, and conductor 128 is extended through the back contact of relays 211, 209 and 207 in series, front contact of relay 205, winding of relay 206 to battery. Relay 206 operates, and, at the end of the impulse, relay 207 operates in series therewith as above explained. Thus at the end of the eighth impulse relays 204, 205, 206, 207, 212 and 213 are operated, and ground is placed on conductors 217, 216 and 219.

When the relay 114 releases at the beginning of the ninth impulse, conductor 128 is extended through the front contact of relay 207 and the winding of relay 208 to battery. Relay 208 oper-

ates, and at the end of the impulse relay 208 operates in series therewith. Relay 208 releases relays 204, 205, 206 and 207. At the end of the ninth impulse relays 208, 209, 212 and 213 are operated, and conductors 218 and 219 are grounded.

Finally, when relay 114 releases at the beginning of the tenth impulse, conductor 128 is extended through the right front contact of relay 209 and the winding of relay 210 to battery. Relay 210 operates, and, at the end of the impulse, relay 211 operates in series therewith. Relay 211 releases relays 208 and 209. Thus at the end of the tenth impulse relays 210, 211, 212 and 213 are energized and the circuit is closed from ground through the inner left front contact of relay 211, outer left front contact of relay 213, to conductor 220.

Having shown how the counting relays respond to the impulse dial 101, it will now be assumed by way of specific example that the subscriber of line 100 dials the designation CH 5678, in which the letter C is represented by a series of two impulses and the letter H is represented by a series of four impulses. In this case the first series of two impulses causes the grounding of conductor 217. Since the conductors 124 are at this time connected through the contacts of relay 122 to the windings of the relays of register A, the grounded conductor 217 may be traced through the contact of relay 122 and the left winding of register relay 130, to battery, and relay 130 operates. At the end of the series of impulses the slow-release relay 126 deenergizes and closes a circuit from ground through its continuity contacts, through the normal contacts of relay 132, conductor 224, thence through the normal contacts of relay 223, and through the normal contacts of similar relays for the intervening registers, thence through the contacts of relays 222 and 221, winding of relay 123, conductor 131, through the contact and right winding of register relay 130 to battery. Relay 130 locks, and relay 123 operates in this circuit before the holding circuit of the counting relays 204 and 205, which is opened by relay 126, is effective in releasing these counting relays. When relay 123 operates it closes a substitute holding circuit for relay 130 and for itself through its front contact to ground. Relay 123 in operating also releases the cut-through relay 122. Relay 123 also closes the circuit for relay 221 of the second register B. This circuit may be traced from battery through the winding of relay 221, normal contact of relay 225, through the contacts of relay 123 to ground. Relay 221 operates and extends the conductors 124 through to the windings of the relays of register B. At the end of the second digit, which comprises a series of four impulses, ground potential is placed on conductor 218 and register relay 226 operates in a circuit through its left winding and through a contact of relay 221 to said grounded conductor 218. When relay 126 releases at the end of this second series of impulses, it grounds conductor 224 as above described and relay 225 is operated in a circuit from battery through the right winding and contact of relay 226, through the winding of relay 225, thence as traced to the grounded conductor 224. Relay 225 at its right contact closes a locking circuit for itself and for the relay 226 independent of conductor 224. Relay 225 also releases relay 221 and closes an operating circuit for the next cut-in relay 222. The full release of relay 126 at the end of the series causes the release of all

operated counting relays. In a similar manner the transmission of the next four series of impulses representing the digits 5, 6, 7 and 8 of the called subscriber's number causes the operation of the corresponding relays of the thousands, hundreds, tens and units registers. The thousands digit 5 causes relay 227 to operate and lock in series with relay 228, the hundreds digit 6 causes the operation of relays in the hundreds register corresponding to relays 229 and 227, the tens digit 7 causes the operation of relays in the tens register corresponding to relays 230 and 227, and the units digit 8 causes relays 231, 232 and 233 to operate and lock in series with relay 234.

The designation of the wanted line 200 having thus been registered on the registers of the sender, the sender now proceeds in the well-known manner to control the selective operation of switch S-1 in accordance with the office code recorded on registers A and B to choose an idle trunk 104 extending to the incoming selector switch S-2 either in the same or in a distant office. Thereafter the sender further controls the selective operation of switches S-2 and S-3 in accordance with the numerical part of the designation to complete the connection through to the called subscriber's line 200. The sender is then released in any well-known manner, and, following the conversation between the subscribers, the established connection is also restored to normal.

Assume next that the subscriber of line 102 equipped with a tone dial 103 initiates a call for the purpose of conversing with the subscriber of line 200. The initiation of the call causes the line finder F to operate and seize the terminals of the calling line and also causes the sender-selector switch S-4 to operate and associate the line finder district link circuit with an idle sender, such as the one illustrated in the drawings. The extension of the subscriber's line through to the idle sender closes the loop circuit previously traced from battery through the right winding of relay 114, thence over conductor 115 and thence over the loop of the calling line and returning to ground by way of conductor 116. Relay 114 energizes and operates relay 121. On a call of this type no impulses are sent over the line by opening and closing same, relay 114 remains energized, and relays 126 and 127 do not operate. Since relay 127 remains deenergized, the tip and ring conductors of the subscriber's line 103 are extended by way of conductors 115 and 116 through to the frequency selecting circuit 105.

The calling subscriber receiving dial tone from the source 125 proceeds to transmit the wanted designation by manipulating his sender 103 in accordance with the letters and numerals of said designation. Each manipulation of the sender causes one or more of the tuned reeds 111 to be set in motion. The microphone 112 is sensitive to the vibrating reeds and modulates the direct current flowing in the line from the central office to produce in said line alternating currents of frequencies corresponding to the vibrating reeds 111. The microphone 112, which is normally short-circuited by the contacts 113, is rendered effective on each manipulation of the sender by the opening of said contacts. These alternating currents are received by any suitable amplifying mechanism 106, which increases their amplitudes and delivers them to the frequency selecting filters 107, 108, 109 and 110. While any suitable frequencies may be used, it will be assumed by

way of example that there are four reeds 111 in the substation sender which vibrate at frequencies 512, 728, 1148 and 1628, and it will be further assumed that the four filters 107, 108, 109 and 110 are tuned to these frequencies respectively. It will be noted that the frequency selecting mechanisms or filters 107, 108, 109 and 110 are provided with relays 133, 134, 135 and 136, respectively, in their output circuits. These relays operate in response to currents of the corresponding frequencies passed by the filter circuits. Relays 133, 134, 135 and 136 in operating cause the operation of the respective locking relays 137, 138, 139 and 140. Therefore, each digit transmitted by the calling subscriber is represented by one or two frequencies causing the operation of either one or two of the relays connected to the output circuits of the selective filters. These relays in turn cause the operation of the common relay 132 and the operation of the corresponding locking relays 137, 138, 139 and 140. Any one of these locking relays in operating locks in a circuit from battery through its winding and left contact, through the common conductor 141, thence through the closed contact of relay 132, to ground at the normal contact of relay 126. The relays 137, 138, 139 and 140 in operating place ground potential on the conductors 124 in the same manner as described in connection with the operation of the counting relays 201. The following table shows the tone responsive relays operated for the several digital numbers:

Digit	Relays operated
1	137
2	138
3	139
4	140
5	137 and 138
6	137 and 139
7	137 and 140
8	138 and 139
9	138 and 140
0	139 and 140

It will be noticed from inspection that relays 137, 138, 139 and 140, when operated in the combinations above listed, cause the conductors 124 to be grounded in the same combinations as was true of the operated counting relays 201 for the same digits.

When the calling subscriber at the substation of line 102 initiated the call as above explained, the cut-through relay 122 operated in a circuit closed by the relay 121. Accordingly, when the first digit is received on relays 137, 138, 139 and 140, the correspondingly grounded conductors 124 cause the operation of one or two or three of the relays of the register A. When the alternating currents representing this first digit cease to flow in the line, the relays in the output circuits of the filters release and open the circuit of relay 132. As the continuity contacts of relay 132 close, a circuit may be traced from ground through the contact of relay 126, through said contacts of relay 132, conductor 224 and thence as traced through back contacts of the different registers, through the winding of relay 123, conductor 131, through the holding windings of the operated relays of register A, to battery. The operated register relays hold and relay 123 operates and closes the locking circuit above described. Relay 123 releases relay 122 and prepares the next register by operating relay 221. On the complete release of relay 132, ground is removed from conductor 141, and the particular one or more of the locking relays 137, 138, 139 and 140 that were

operated are released to remove ground potential from conductors 124. In a similar manner the transmission of tone currents for the remaining digits of the wanted designation causes the registration of these digits on the corresponding registers at the central office.

Thereafter the sender controls the selective operation of the switches to complete the establishment of the connection from the calling line 102 to the called line 200. Following the completion of its functions, the sender is restored to normal in the well-known manner, and, when the subscribers have completed their conversation, the automatic switches are also restored to normal.

A description will now be given of the alternative tone receiving mechanism illustrated in Figs. 3, 4 and 5. This alternative mechanism, the circuits for which are illustrated in Fig. 3, may be substituted for the frequency selective mechanism 105 shown in Fig. 1. It consists essentially of an electromagnetic device 300 comprising an electromagnet and four tuned reeds 301, 302, 303 and 304, mounted to vibrate in response to currents flowing through the winding of the magnet. These reeds are provided, respectively, with small mirrors 305, 306, 307 and 308, which serve to reflect beams of light from a common source 309 to corresponding photoelectric cells 310, 311, 312 and 313. When no current of a frequency to which the reeds are responsive is flowing in the magnet 300, the mirrors are at rest and the beams of light from the source 309 do not enter the windows 314, 315, 316 and 317 of the photoelectric cells. This is illustrated best in Fig. 5 of the drawings. When, however, currents of the proper frequencies flow in the magnet 300, one or more of the reeds are set in vibration and the beams of light are directed through the windows of the photoelectric cells to cause their excitation. For example, when the mirror 307 is set in vibration, the beam of light 322 first is reflected directly into the window 316 of cell 312, as indicated by the line 323, during half of the vibratory cycle of the reed, and is reflected indirectly by way of a stationary mirror 324 through the window 316, as indicated by the line 325, during the other half of the vibratory cycle of the reed. Thus the photoelectric cell receives a substantial amount of light when the mirror is vibrated. The currents resulting from the excitation of the photoelectric cells are amplified in any suitable way by amplifiers 318, 319, 320 and 321 and the currents from these amplifiers cause the operation of relays 326, 327, 328 and 329. These relays, which correspond to relays 133, 134, 135 and 136 of the mechanism 105, cause the operation, respectively, of the locking relays 137, 138, 139 and 140.

With the central office register sender equipped with the frequency selective register sender of Figs. 3, 4 and 5, the tone currents transmitted by the calling subscriber's sender 103 pass over conductors 115 and 116, through the contacts of relay 127, thence to the amplifier 335 and to the frequency responsive electromagnetic device 300. The reeds and mirrors are set in vibration and the corresponding photoelectric cells are energized to cause the operation of the proper combination of the relays 326, 327, 328 and 329. The manner in which the several digits are registered on the registers of the sender is substantially the same as that already described and no further detailed explanation is believed to be necessary.

What is claimed is:

1. In a telephone system, a telephone line, a transmitter for said line for sending series of

direct current impulses representing telephone designations, a second telephone line and a transmitter therefor for sending over the line alternating currents of different frequencies representative of telephone designations, a receiving mechanism arranged to cooperate with either of said lines and to receive either the direct current impulses transmitted over said first-mentioned line or the alternating currents transmitted over said second line, and means controlled by said receiving mechanism in accordance with the designations received over said lines for establishing telephone connections.

2. In a telephone system, a telephone line, a transmitter for said line for sending series of current impulses representing telephone designations, a second telephone line and a transmitter therefor for sending alternating currents of different frequencies representing telephone designations, a receiving mechanism having a series of counting relays for receiving the series of impulses transmitted over said first mentioned line, frequency selective devices in said receiving mechanism responsive to the alternating currents transmitted over said second line, and registering mechanism controlled either by said counting relays or by said frequency selective devices for registering the designations received over said lines and for establishing telephone connections.

3. In a telephone system, a telephone line having an impulse dial for sending direct current impulses over the line, a second telephone line having a transmitter for sending alternating currents of different frequencies over said second line, a central office in which said lines terminate, a register sender in the central office, means for associating said sender with either one of said lines in response to a call thereon, a series of counting relays in said sender responsive to a series of direct current impulses representing a wanted designation transmitted over said first-mentioned line by said dial, tuned selective devices responsive to alternating currents of different frequencies transmitted over said second-mentioned line in accordance with wanted designations, means for rendering said tuned selective devices ineffective when direct current impulses are being transmitted to said sender, and register means responsive either to said counting relays or to said tuned selective devices to register wanted designations.

4. In a telephone system, a telephone line, means for transmitting over said line currents of different frequencies representing the different parts of a telephone designation, registers for recording designations, photoelectric means selectively energized in accordance with the frequencies of the currents transmitted over said

line, and means controlled by said photoelectric means for operating said registers to record the wanted designations.

5. In a telephone system, a telephone line, means for transmitting over said line currents of different frequencies representing the different parts of a telephone designation, tuned frequency selecting devices responsive to the currents of different frequencies transmitted over said line, photoelectric mechanism selectively operated by said frequency selecting devices in accordance with the different parts of a telephone designation, and switch controlling registers responsive to said photoelectric mechanism for registering the desired designations.

6. In a telephone system, a telephone line, a transmitter for said line for sending direct current impulses on a decimal basis to represent wanted telephone designations, a second telephone line and a transmitter therefor for sending alternating currents of different frequencies to represent the wanted telephone designations, a line finder switch for extending either one of said lines when calling, automatic selector switches, a number of register senders, each common to all of said switches, means associated with said finder for selecting an idle one of said register senders and for extending either of said lines when calling to the selected sender, counting relays in the sender for receiving a series of direct current impulses when transmitted over said first-mentioned line, frequency selective devices in the sender for receiving the alternating currents when transmitted over said second line, and registers in the sender controlled either by said counting relays or by said frequency selective devices for registering the designations received over said lines and for controlling the selective operation of said automatic switches.

7. In a telephone system, a telephone line, a transmitter for said line for sending series of direct current impulses representing telephone designations, a second telephone line having a transmitter for sending alternating currents of different frequencies representing telephone designations, a central office register sender having a series of counting relays for receiving the direct current impulses when transmitted over said first line, frequency selective devices in said register sender responsive to the alternating currents when transmitted over said second line, a plurality of digit registers in said center for registering the designations received by said counting relays, and photoelectric means responsive to said frequency selective devices for operating said registers to register thereon the designations transmitted over said second line.

HENRY M. BASCOM.